GUEST EDITORIAL

INTEGRATED COMMUNICATIONS, CONTROL, AND COMPUTING TECHNOLOGIES FOR ENABLING AUTONOMOUS SMART GRID

				
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The electricity grid is facing four major challenges — increasing electricity demand, ageing grid infrastructure, ever-increasing penetration of renewables, and significant uptake of electric vehicles. To address these challenges, it is of vital importance to integrate modern communications, control, and computing technologies into one of the most complicated systems on earth, the electricity grid, for building an autonomous smart grid.

The realization of the autonomous smart grid will require collaborative and sustained efforts from the Societies of Power Electronics, Power & Energy, Control, Communications, and Computing over the years to come. This Feature Topic aims to facilitate this sustained effort by disseminating general ideas extracted from cutting-edge research results spanning multiple disciplines. We received 16 submissions from around the world, and only 7 papers were selected for publication.

To integrate advanced technologies for enabling an autonomous smart grid, we must have a scalable and flexible communication framework. Two articles address such a need. The first article entitled ``Distributed Communication Architecture for Smart Grid Applications'' presents a distributed architecture in the smart grid that processes data locally. In the scenario therein, communication distances are shortened and thus power data can be delivered reliably. The second article entitled ``Software Defined Networking for Flexible and Green Energy Internet'' brings up a new version of an energy system termed Energy Internet that can provide highly efficient

interconnection among various grid components, such as renewable energy resources, energy storages, and loads. A software defined Energy Internet architecture that allows peer-to-peer energy delivery on a large scale is discussed.

Having a robust communication framework with flexibility and scalability, we envision high penetration of electric vehicles (EVs) into the future power grid, providing new challenges and opportunities to the grid performance. In our third article, ``Online Charging Scheduling Algorithms of Electric Vehicles in Smart Grid: An Overview,'' a comprehensive review on state-of-the-art online EV charging algorithms is conducted. Those algorithms can address different degrees of uncertainty and randomness induced from EV charging while harvesting a few benefits of grid management such as load flattening and fast frequency control. The fourth article, ``Vehicular-Publish/Subscribe (V-P/S) Communication Enabled On-the-move EV Charging Management,'' investigates a communication scheme that supports on-the-move EV charging management. Related open research topics, for example, oriented information dissemination, integration of renewable energy and advanced charging technologies, and vehicle-to-grid operation, are examined as well. The fifth article, ``Energy Management Framework for Electric Vehicles in the Smart Grid: A Three-Party Game,'' considers the interaction between the EVs, power grid, and smart communities (SCs). Two energy management schemes termed SC-centered and EV centered systems are introduced.

Our first five articles cover various aspects on the realization of an autonomous smart grid. Autonomous smart grids lead to a number of heterogeneous applications based on machine-to-machine (M2M) communications, but communication authentication becomes increasingly challenging because of the increasing number of M2M nodes. In the sixth article, ``A Framework of Machine-to-Machine Authentication in Smart Grid: A Two-Layer Approach,'' an authentication scheme for advanced metering infrastructure that employs smart meters to enable two-way communications between meters and electric utilities is designed. The underlying idea is that public key infrastructure and channel signatures are used to authenticate smart meters globally and locally, respectively.

Successful operations of autonomous smart grids rely on not only integration of technologies but also regional or national policy and regulations. The seventh article in our Feature Topic entitled ``Making Demand Response a Reality in Europe: Policy, Regulations and Deployment Status'' provides a timely discussion on related issues, including European policy to the adoption of demand response, assessment of

European regulatory, European standardization aspects related to demand response, and commercial demand response services in Europe. Although only Europe is in focus, ideas and concepts therein should shed some light on policy making and regulations pertaining to demand response in other non-European countries around the world.

The coverage of this Feature Topic is by no means comprehensive. Due to space limitation, a number of exciting topics are missing. We encourage our readers to investigate further and hope our Feature Topic can facilitate spreading brilliant ideas and bringing up new research directions. Finally, we would like to thank our reviewers and authors for your valuable time and inputs.

BIOGRAPHIES

Wei-Yu Chiu [M'11] received the Ph.D. degree in communications engineering from National Tsing Hua University, Hsinchu, Taiwan, in 2010. He was a Postdoctoral Research Fellow with Princeton University in 2011-2012, and a Visiting Scholar with Oklahoma State University in 2015. He is currently an Assistant Professor of Electrical Engineering with Yuan Ze University, Taoyuan, Taiwan. His research interests include multicriteria decision making, multiobjective evolutionary algorithms, optimization theory, and smart grid.

Hongjian Sun [S'07-M'11-SM'15] received his Ph.D. degree from the University of Edinburgh (U.K.) in 2011 and then took postdoctoral positions at King's College London (U.K.) and Princeton University (USA). Since 2013, he has been with the University of Durham, U.K., as a Lecturer in Smart Grid. His research mainly focuses on: (i) Smart grid: communications and networking, (ii) Smart grid: demand side management and demand response, and (iii) Smart grid: renewable energy sources integration.

John Thompson [M'94-SM'13-F'16] currently holds a personal chair in Signal Processing and Communications in University of Edinburgh, UK. He was deputy academic coordinator for Mobile Virtual Centre of Excellence Green Radio project and now leads the UK SERAN project for 5G wireless. He also currently leads the European Marie Curie Training Network ADVANTAGE which trains 13 PhD students in Smart Grids. He was a distinguished lecturer on green topics for ComSoc in 2014-2015.

Kiyoshi Nakayama completed his Ph.D. degree in Computer Science at the University of California, Irvine in June, 2014, and then spent a year at Fujitsu Laboratories of America as a Postdoctoral Research Associate in smart energy research group. He is

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Shunqing Zhang [S'05-M'09-SM'14] received the Ph.D. degree in 2009 from the Department of Electrical and Computer Engineering, Hong Kong University of Science and Technology, Hong Kong, China. He is currently the senior research scientist and the associate director of Intel Collaborative Research Institute on Mobile Networking and Computing, Intel Labs. His current research interests include smart-grid communications and networks, energy efficient 5G communication networks, non-orthogonal waveform design, and energy efficient communications.